

DISCUSSION ON VISTULA LAGOON MUNICIPALITIES' DEVELOPMENT WITH REGARD TO CLIMATE CHANGES

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Most part of the Vistula Lagoon coastal area is a low-lying land, so it is highly vulnerable to sea level rise and to other potential impacts of climatic changes. Vistula Lagoon is a trans-border water area (Domnina, Chubarenko, 2007). South-western part of the lagoon belongs to the Republic of Poland, and north-eastern part belongs to the Russian Federation. Environmental conditions in the lagoon vicinity, and especially their dynamics with regard to climatic changes, may have an impact on the economic activities of territorial-administrative entities which have a direct access to the Lagoon.

This paper (a) provides information on Russian and Polish territorial-administrative entities, which border the lagoon, (b) gives a review of strategies of their development (c) shows the results of analysis of the stated strategic objectives tolerance in relation to expected climatic changes.

The Lagoon has an elongated shape, it is stretched along the coast (Figure 1) and is connected with the sea by the only Baltiysk Strait, where the navigational fairway passes (with 12-14 m depth). The total water surface area of the lagoon is 815 km² (Chubarenko, 2008). The most part of the lagoon (495 km²) is located within the Kaliningrad Oblast (Russia), and the rest part (320 km²) is situated in Poland. The length of the lagoon from north to south is 88 km, the width is 7-12 km. The average depth is 2,6 m, the maximum depth is 12 m (excluding ship channel). The coastline is characterized by alternation of concave segments with sandy beaches and short capes covered by vegetation. The water area of the largest bay - Primorsk Bay - is bordered by a ship channel dam islands. The region climate is mild, wet with warm winter and cold summer (Tersiev, 1985).



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Advanced tool for scenarios of the Baltic Sea ECOSystem to SUPPORT decision making (ECOSUPPORT)

Municipalities	Area, km ²	Population, thousands	Population per 1 km ²
Kaliningrad city	223	427	1914,8
Zelenogradsk district	2016,49	31,5	15,1
Primorsk town	101,3	36,7	362,4
Gdansk district	1363	50,5	37,1
Bagrationovsk district	1146	33,3	29,1
Stegina town	109	1,7	15,6
Krynica Morska town	78,2	3,3	42,3
Elblag town	117,05	1,5	12,8
Average in Russian part	698,6	22	31,5
Elblag, gmina	192,1	6,46	33,6
Stegina, gmina and town	27,3	0,7	25,6
Primorsk, gmina and town	101,3	36,7	362,4
Nowy Dwor Gdanski, gmina and town	125,8	12,9	102,4
Nowy Dwor Gdanski, gmina and town	17,6	17,87	84
Krynica Morska, gmina	109	13,71	124
Stegina, gmina	109,6	1,52	13,7
Elblag, gmina	109,6	1,52	13,7
Average in Polish part	1227,7	38,21	31,5



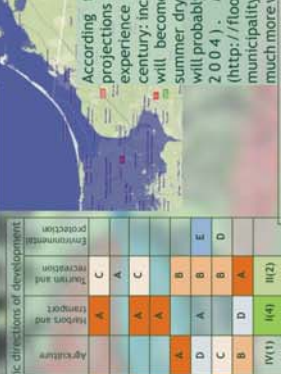
Municipalities	Food production	Industry	Agriculture	Tourism and recreation	Environment protection
Braniewo, gmina					
Elblag, town					
Frombork, town					
Sztutowo, gmina					
Stegina, gmina					
Krynica Morska, town					
Nowy Dwor Gdanski, gmina and town					
Tolkimiko, gmina and town					
Total number of directions (popularity)	4	1	4	2	9

Municipalities	Environment protection	Tourism and recreation	Agriculture	Industry	Food production
Kaliningrad urban district	B	A	C		
Ladushkin urban district	B	A	C		
Mamonovo urban district	B	A	C		
Svetly town	B	A	C		
Bagrationovsk district	C	D	A	B	
Baltiysk district	C	D	A	B	
Gu'levsk district	C	D	A	B	
Zelenogradsk district	C	D	A	B	
All Russian municipalities of the Vistula Lagoon	III(1)	IV(1)	II(4)	II(2)	
Popularity	6	4	5	7	2

Baseline information from public sources, and (www.gov39.ru) for the Kaliningrad Oblast, and (www.zaliewo.pl) for the Polish part of Vistula Lagoon area) was used for municipalities' development strategies analysis. The administrative-territorial division of Polish and Russian parts of the Vistula Lagoon is different. Polish administrative units bordered to the Vistula Lagoon are smaller than Russian ones.

Coastal municipalities in their development rely primarily on development of tourism, recreation, and port infrastructure, while the inner municipalities, which do not have an access to the lagoon coastline, focus on agriculture and industry development. Mostly, such economic orientation is due to the historical reasons.

According to the scaling of global climate model projections to the South-East part of Baltic Sea will experience the following effects to the end of XXI century: increasing of air temperature, vegetation period will become longer, winter will be more humid and summer dryer (Storch, Omstedt, 2008). River discharge will probably reduce and sea salinity will grow (Meier et al. 2004). Models of territory flooding (<http://flood.firetree.net/>) also show, that flooded municipality areas of Polish part of Vistula Lagoon are much more wider than for Russian ones.



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Mamonovo urban district	B	A	C		
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Bagrationovsk district	C	D	A	B	
Baltiysk district	C	D	A	B	
Gu'levsk district	C	D	A	B	
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Popularity	6	4	5	7	2

How were estimated gradations of tolerance?
Some negative climate changes and impacts:
Sea level rising
Area of possible flooded territories
Rising of groundwater level
Periodical flooding of roads and streets
Expensive prevention of flooding
Extreme weather conditions
Eutrophication
Some positive climate changes and impacts:
Increasing of air and water temperature
Winter is warmer
Increasing of vegetation period

Municipalities	Food production	Industry (small size)	Agriculture	Protection	Maritime and transport	Fishery	Tourism and recreation	Nature conservation	Total assessment
Kaliningrad, town									
Ladushkin, town									
Mamonovo, town									
Svetly, town									
Bagrationovsk, district									
Baltiysk, district									
Gu'levsk, district									
Zelenogradsk, district									
Braniewo, town									
Elblag, gmina									
Elblag, town									
Frombork, town and gmina									
Sztutowo, gmina									
Stegina, gmina									
Krynica Morska, town									
Nowy Dwor Gdanski, town and gmina									
Tolkimiko, town and gmina									
Number of high sustainable	4	4	-	2	-	7	1	6	
Number of medium sustainable	7	-	-	3	2	3	1	4	
Number of low sustainable	1	4	4	4	3	6	7	7	

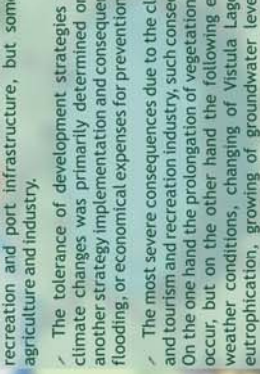
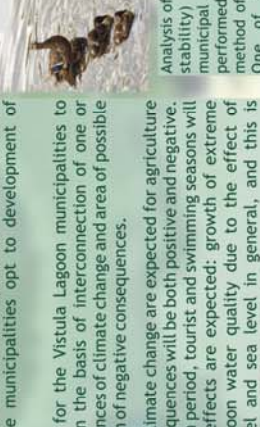
Strategic directions of development:
The main priority development direction (I)
The 2nd priority development direction (II)
The 3rd priority development direction (III)
The 4th priority development direction (IV)
The 5th priority development direction (V)
The 6th priority development direction (VI)
The 7th priority development direction (VII)
The 8th priority development direction (VIII)
The 9th priority development direction (IX)
The 10th priority development direction (X)
The 11th priority development direction (XI)
The 12th priority development direction (XII)
The 13th priority development direction (XIII)
The 14th priority development direction (XIV)
The 15th priority development direction (XV)
The 16th priority development direction (XVI)
The 17th priority development direction (XVII)
The 18th priority development direction (XVIII)
The 19th priority development direction (XIX)
The 20th priority development direction (XX)

Weak tolerant
Development plans much depend on consequences of climate change. The risk of negative effects, connected with economic expenditures, is high. The area of possible flooded territories is very high (50 to 90% of area of municipality).
Mean tolerant
Development plans are dependent on consequences of climate change. The risk of negative effects, connected with economic expenditures, is medium. The area of possible flooded territories is medium (30 to 50% of area of municipality).
High tolerant
Plans do not depend on consequences of climate change. The risk of negative effects, connected with economic expenditures, is low. The area of possible flooded territories is low (10 to 30% of area of municipality).

Conclusions.
Changing of climate characteristics and threat of flooding will cause more and more, gradually increasing impact on all kinds of economic activities in and around the Vistula Lagoon.
Coastal municipalities in their development mostly rely on development of tourism, recreation and port infrastructure, but some municipalities opt to development of agriculture and industry.
The tolerance of development strategies for the Vistula Lagoon municipalities to climate changes was primarily determined on the basis of interconnection of one or another strategy implementation and consequences of climate change and area of possible flooding, or economic expenses for prevention of negative consequences.
The most severe consequences due to the climate change are expected for agriculture and tourism and recreation industry, such consequences will be both positive and negative. On the one hand the prolongation of vegetation period, tourist and swimming seasons will occur, but on the other hand the following effects are expected: growth of extreme weather conditions, changing of Vistula Lagoon water quality due to the effect of eutrophication, growing of groundwater level and sea level in general, and this is especially critical for low-lying coastal territories of the Vistula Lagoon.
Strategies and development trends of 17 municipalities of Russia (Kaliningrad Oblast) and Poland (Warmino-Mazurskie and Pomorskie Voivodeship) were analyzed in this work. Generally, development strategies of Russian municipalities are more tolerant to the consequences of climate change. Strategic directions of economic activities in Polish municipalities are less tolerant in comparison with Russian ones due to large possible flooding areas or high economic expenses for prevention of flooding. Only development strategy of Krynica Morska is characterized by high tolerance because possible flooding area is small.
Inclusion of concern on climate changes in the management issues related to water resources will simplify adaptation to the further climate changing. Herein it is necessary to consider, that any measures for adaptation to the climate changes require economic expenses and settlement of potential conflicts among different economic activities.

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http://www.gov39.ru/index.php?option=com_content&view=article&id=51&Itemid=49 - Government of the Kaliningrad Oblast. Municipalities.
http://www.zaliewo.pl/index.php?option=com_content&view=article&id=20&Itemid=20 - Government of the Polish part of Vistula Lagoon.

Analysis of tolerance (possible stability) of strategies of municipal development was performed by the qualitative method of expert evaluation.
One of three qualitative characteristics (high, average and low tolerance) was assigned for each municipality development strategy.



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